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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/583,386	05/30/2000	L. Richard Carley	000265	1365

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EXAMINER

KIELIN, ERIK J

ART UNIT	PAPER NUMBER
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2813

DATE MAILED: 06/19/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/583,386

Applicant(s)

CARLEY, L. RICHARD

Examiner

Erik Kielin

Art Unit

2813

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 07 May 2002.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-4, 21 and 22 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-4, 21 and 22 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ 6) ☐ Other: _____

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 7 May 2002 has been entered.

Claim Objections

2. In amended claim 1, line 7, remove the period because a claim must be one sentence.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 1-3, 21, and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over US 5,493,177 (**Muller** et al.) in view of US 5,843,333 (**Seefeldt** et al.) and US 5,573,679 (**Mitchell** et al.).

Muller, a reference provided by Applicant and discussed in the instant specification at page 2, discloses a method of fabricating a microstructure in a sealed cavity comprising, providing a substrate 38 (Figs. 8J1, 8J2);

forming a microstructure **24, 28, 116**, (called “filaments” in **Muller**, col. 10, line 4)
composed of a structural material on said substrate, said microstructure being secured to said
substrate by a first layer of sacrificial material **177** (Figs. 8C1-8D2);

forming a second layer of sacrificial material **184** on said microstructure (Figs. 8G1-
8G2);

forming a cap **186** on said second layer of sacrificial material, said cap forming a sealed
cavity containing said microstructure and said first and second sacrificial layers (Figs 8H1-8H2);

forming one or more holes **32, 34** in said sealed cavity, said holes being restricted to an
area of said sealed cavity not directly above said microstructure (Figs. 8I2, 8J2; col. 10, lines 31-
33);

introducing hydrofluoric acid into said sealed cavity through said one or more holes, said
structural material and said sacrificial material having a high etch rate differential with respect to
said etchant, such that said sacrificial material is removed (col. 10, lines 46-50); and

sealing said one or more holes in said sealed cavity (Figs 8K1-8K2; col. 10, lines 53-55).

(See also col. 9, line 15 to col. 10, line 60 for information associated with the
aforementioned figures.)

Muller does not teach indicate whether or not the etchant is liquid or “non-liquid” and
would not appear, therefore, to be limited to a particular phase for the etchant.

If it is thought the **Muller** is somehow limited to liquid etchants, even in the absence of
an indication of the phase of the etchant, then this may be a difference.

Seefeldt discloses a method of forming a microstructure **52** (Fig. 20) wherein the
sacrificial material **223** made of silicon dioxide (like that sacrificial layer **184** of **Muller**) is
removed using HF (hydrofluoric acid) vapor, introduced through holes **233** which are later sealed

237 (Fig. 21) to beneficially eliminate the step of rinsing and drying the microstructure in the sealed cavity (col. 9, lines 42-61).

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use a non-liquid etchant (i.e. HF vapor) as taught by **Seefeldt** in the disclosed method of Muller because Muller does not appear to be limited to a liquid etchant and for the reasons indicated in **Seefeldt** to beneficially eliminate the rinsing and drying steps thereby improving process throughput.

Then the only difference is that neither Muller nor Seefeldt teach that the etchant is introduced by a barrel etcher. However, it has been held that to be entitled to weight in method claims, the recited structure limitations therein must affect the method in a manipulative sense, and not amount to the mere claiming of a use of a particular structure. Ex parte Pfeiffer, 1962, C.D. 408 (1961). In the instant case, it does not matter how the etchant is introduced so long as it is a “non-liquid” to meet the criteria established by Applicant to meet the inventive value of eliminating a liquid etchant.

If it is thought however that the barrel etcher has patentable weight, then this may be a difference. But **Mitchell** teaches a method of removing sacrificial material 24 through holes 34 (Fig. 2D) using a “fluorine-containing” species introduced by a barrel etcher (called “barrel reactor” therein; col. 4, lines 1-13).

It would have been obvious for one of ordinary skill in the art, at the time of the invention to introduce the hydrofluoric acid vapor etchant using a barrel etcher, because **Seefeldt** is silent to the method of introducing the vapor etchant, such that one of ordinary skill would be motivated to seek out an apparatus for carrying out the etching, such as the one in Mitchell since the processes are similar for introducing fluorine-containing etchants which are “non-liquid” into

holes to isotropically remove sacrificial material. Furthermore, Applicant has not indicated that the apparatus by which the “non-liquid etchant” is introduced is somehow critical or manipulative of the method.

Regarding claims 2, 21, and 22 it is seen to be inherent in **Muller** and **Seefeldt**, that the etchant does not significantly etch the structural materials therein because the structures are shown to remain after the sacrificial material is etched away. Similarly, the etchant etches the sacrificial material faster and the structural material slower and the structural material is very clearly resistant to the etchant. If these limitations were not met by **Muller** then no microstructure could effectively be formed, in direct contrast to what is shown in the applied references.

Regarding claim 3, as noted by Applicant in the specification on page 2 regarding the **Muller** reference, the substrate is silicon with a protective silicon nitride layer 178 is formed thereon.

5. Claims 1-3, 21, and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Muller** in view of US 5,578,976 (**Yao**).

Regarding claim 1, the prior art of **Muller**, as explained above, discloses each of the claimed features except for using a non-liquid etchant introduced by a barrel etcher.

Yao teaches a method of forming a MEMS comprising providing a substrate 12, sacrificial layers of photoresist 30, 38 (called “polyimide” in **Yao**; Figs 5A-6E) which secure the MEMS to the substrate until etched away, and structural material of aluminum 22, 24. **Yao** also discloses that it is especially beneficial to use a barrel etcher with an oxygen plasma to remove the sacrificial layers in order to circumvent problems associated with surface tension created by

wet etching. (See **Yao**, col. 5, lines 41-65 and especially col. 6, lines 6-13.) Note that the instant specification indicates the objective of the instant invention is to overcome the problems of surface tension by using a "non-liquid etchant" for at least the removal of the last sacrificial layer (specification, p. 3, lines 10-24.)

It would have been obvious for one of ordinary skill in the art, at the time of the invention, to modify the **Muller** invention to use the structural materials and sacrificial materials of **Yao** and consequently the barrel etcher and oxygen plasma to remove the sacrificial layers of polyimide from the aluminum structural material for the reasons indicated in **Yao**, as just noted, which are incidentally the same as Applicant's reasons. One of ordinary skill would be especially motivated to modify the **Muller** process because **Muller** is not limited to any specific structural or sacrificial materials, as made clear by the claims therein, and because the **Yao** materials and methods allows the prevention of sticking of the microstructure.

It is also noted that Applicant indicated in the section entitled "REMARKS," the last paragraph--especially the last sentence, Paper No. 7, in responding to the first office action that aluminum is the preferred structural material and photoresist is the preferred sacrificial material (the same as in **Yao**) due to the high etch selectivity in oxygen plasma.

6. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Muller** in view of **Yao** as applied to claims 1 and 2 above, and further in view of and **Wolf**, et al. Silicon Processing for the VLSI Era, Vol. 1-Process Technology, Lattice Press: Sunset Beach CA, 1986, pp. 428-429.

The prior art of **Muller** in view of **Yao**, as explained above, discloses each of the claimed features including the structural material being fabricated from aluminum and the sacrificial material is made of polyimide, but Yao does not state the polyimide is a photoresist.

Wolf teaches that polyimides are known photoresists. (See pp. 428-429.)

It would have been obvious for one of ordinary skill in the art, at the time of the invention to use the polyimide of **Yao** as a photoresist as taught by **Wolf** to beneficially eliminate process steps whereby the sacrificial layer needs patterning thereby eliminating additional patterning process steps which is highly desired in the art and also because **Wolf** recognizes that polyimides are photoresist materials.

Response to Arguments

7. Applicant's arguments with respect to claims 1-4, 21, and 22 have been considered but are moot in view of the new ground(s) of rejection.

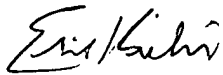
Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 703-306-5980.

The examiner can normally be reached on 9:00 - 19:30 on Monday through Thursday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached at 703-306-2417. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.



Erik Kielin

June 15, 2002